

**In the Claims:**

**Claim 1 (currently amended):** A method of fabricating a semiconductor device, having a copper-zinc alloy (Cu-Zn) ~~thin~~ film formed on a copper (Cu) surface by electroplating the Cu surface in a chemical solution, comprising the steps of:

- providing a semiconductor substrate having a Cu surface;
- providing a chemical solution;
- electroplating the Cu surface in the chemical solution, thereby forming a Cu-Zn alloy ~~thin~~ film on the Cu surface;
- rinsing the Cu-Zn alloy ~~thin~~ film in a solvent;
- drying the Cu-Zn alloy ~~thin~~ film under a gaseous flow; and
- ~~completing formation of the semiconductor device~~

wherein the Cu-Zn alloy film has a zinc (Zn) content in a concentration range of approximately 0.10 atomic % to approximately 1.0 atomic %.

**Claim 2 (original):** A method, as recited in Claim 1, wherein the chemical solution is nontoxic and aqueous, and wherein the chemical solution comprises:

- at least one zinc (Zn) ion source for providing a plurality of Zn ions;
- at least one copper (Cu) ion source for providing a plurality of Cu ions;
- at least one complexing agent for complexing the plurality of Cu ions;
- at least one pH adjuster; and

at least one wetting agent for stabilizing the chemical solution, all being dissolved in a volume of deionized (DI) water.

**Claim 3 (currently amended):** A method, as recited in Claim 2, wherein the at least one zinc (Zn) ion source comprises at least one zinc salt selected from a group consisting essentially of zinc acetate ((CH<sub>3</sub>CO<sub>2</sub>)<sub>2</sub>Zn), zinc bromide (ZnBr<sub>2</sub>), zinc carbonate hydroxide (ZnCO<sub>3</sub>·2Zn(OH)<sub>2</sub>), zinc dichloride (ZnCl<sub>2</sub>), zinc citrate ((O<sub>2</sub>CCH<sub>2</sub>C(OH)(CO<sub>2</sub>)CH<sub>2</sub>CO<sub>2</sub>)<sub>2</sub>Zn<sub>3</sub>), zinc iodide (ZnI<sub>2</sub>), zinc L-lactate ((CH<sub>3</sub>CH(OH)CO<sub>2</sub>)<sub>2</sub>Zn), zinc nitrate (Zn(NO<sub>3</sub>)<sub>2</sub>), zinc stearate ((CH<sub>3</sub>CH<sub>2</sub>)<sub>16</sub>CO<sub>2</sub>)<sub>2</sub>Zn), zinc sulfate (ZnSO<sub>4</sub>), zinc sulfide (ZnS), zinc sulfite (ZnSO<sub>3</sub>), and their hydrates.

**Claim 4 (previously presented):** A method, as recited in Claim 2, wherein the chemical solution further comprises at least one complexing agent for complexing the plurality of Zn ions being dissolved in the volume of DI water, wherein the at least one complexing agent for complexing the plurality of Zn ions comprises tartaric acid (HO<sub>2</sub>CCH(OH)CH(OH)CO<sub>2</sub>H), and wherein the tartaric acid prevents precipitation of the plurality of Zn ions from the chemical solution.

**Claim 5 (currently amended):** A method, as recited in Claim 2, wherein the at least one copper (Cu) ion source comprises at least one copper salt selected from a group

consisting essentially of copper(I) acetate ( $\text{CH}_3\text{CO}_2\text{Cu}$ ), copper(II) acetate ( $(\text{CH}_3\text{CO}_2)_2\text{Cu}$ ), copper(I) bromide ( $\text{CuBr}$ ), copper(II) bromide ( $\text{CuBr}_2$ ), copper(II) hydroxide ( $\text{Cu}(\text{OH})_2$ ), copper(II) hydroxide phosphate ( $\text{Cu}_2(\text{OH})\text{PO}_4$ ), copper(I) iodide ( $\text{CuI}$ ), copper(II) nitrate hydrate ( $(\text{CuNO}_3)_2$ ), copper(II) sulfate ( $\text{CuSO}_4$ ), copper(I) sulfide ( $\text{Cu}_2\text{S}$ ), copper(II) sulfide ( $\text{CuS}$ ), copper(II) tartrate ( $(\text{CH}(\text{OH})\text{CO}_2)_2\text{Cu}$ ), and their hydrates.

**Claim 6 (currently amended):** A method, as recited in Claim 2,  
wherein the at least one complexing agent for the plurality of Cu ions comprises at  
least one species selected from a group consisting essentially of ethylene diamine "EDA"  
( $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$ ) and ethylenediaminetetraacetic acid "EDTA"  
( $(\text{HO}_2\text{CCH}_2)_2\text{NCH}_2\text{CH}_2\text{N}(\text{CH}_2\text{CO}_2\text{H})_2$ ), and  
wherein the at least one complexing agent for the plurality of Cu ions prevents  
precipitation of the plurality of Cu ions from the chemical solution.

**Claim 7 (currently amended):** A method, as recited in Claim 2, wherein the at  
least one pH adjuster comprises at least one pH-adjusting compound selected from a  
group consisting essentially of ammonium hydroxide ( $\text{NH}_4\text{OH}$ ) and  
tetramethylammonium hydroxide "TMAH" ( $(\text{CH}_3)_4\text{NOH}$ ).

**Claim 8 (currently amended):** A method, as recited in Claim 2, wherein the at

least one wetting agent comprises a surfactant, and wherein the surfactant comprises at least one material selected from a group consisting essentially of RE-610<sup>TM</sup> and polyethylene glycol (PEG).

**Claim 9 (currently amended):** A method, as recited in Claim 1,  
wherein the Cu surface is formed by a process selected from a group consisting  
essentially of chemical vapor deposition (CVD), plasma vapor deposition (PVD), plasma  
enhanced chemical vapor deposition (PECVD), electroplating, and electroless plating,  
wherein said solvent comprises water, and  
wherein said gaseous flow comprises gaseous nitrogen (GN<sub>2</sub>).

**Claim 10 (currently amended):** A method, as recited in Claim 2,  
wherein the at least one zinc (Zn) ion source is provided in a concentration range  
of approximately 5 g/L to approximately 25 g/L,  
wherein the at least one complexing agent for complexing the plurality of Zn ions  
is provided in a concentration range of approximately 10 g/L to approximately 30 g/L,  
wherein the at least one copper (Cu) ion source is provided in a concentration  
range of approximately 5 g/L to approximately 25 g/L,  
wherein the at least one complexing agent for complexing the plurality of Cu ions  
is provided in a concentration range of approximately 40 g/L to approximately 100 g/L,  
wherein the at least one pH adjuster is provided in a concentration range of

approximately 10 g/L to approximately 20 g/L,

wherein the at least one wetting agent is provided in a concentration range of approximately 0.01 g/L to approximately 0.1 g/L,

wherein the volume of DI water is provided in a volume range of up to and including 1 L,

wherein the at least one pH adjuster adjusts the chemical solution to a pH in a range of approximately 7.5 to approximately 14,

wherein the chemical solution is maintained at a temperature in a range of approximately 16°C to approximately 35°C,

wherein the Cu surface is immersed for a time duration in a range of approximately 15 seconds to approximately 120 seconds, and

wherein the Cu-Zn alloy ~~thin~~ film is formed having a thickness in a range of approximately 10 nm to approximately 200 nm, and

~~wherein the formed Cu-Zn alloy thin film is Zn content in a concentration range of approximately 0.10 atomic % to 1 atomic %.~~

**Claims 11-20 (canceled).**

**Claim 21 (previously presented):** The method of Claim 2 wherein the at least one complexing agent comprises ethylenediaminetetraacetic acid "EDTA"  $((\text{HO}_2\text{CCH}_2)_2\text{NCH}_2\text{CH}_2\text{N}(\text{CH}_2\text{CO}_2\text{H})_2)$ .

**Claim 22 (previously presented):** The method of Claim 2 wherein the at least one pH adjuster comprises tetramethylammonium hydroxide "TMAH" ((CH<sub>3</sub>)<sub>4</sub>NOH).

**Claims 23-24 (canceled).**

**Claim 25 (previously presented):** The method of Claim 2 wherein:  
the at least one zinc (Zn) ion source is provided in a concentration range of approximately 5 g/L to approximately 25 g/L; and  
the at least one copper (Cu) ion source is provided in a concentration range of approximately 5 g/L to approximately 25 g/L.

**Claim 26 (previously presented):** The method of Claim 2 wherein the at least one pH adjuster adjusts the chemical solution to a pH in a range of approximately 7.5 to approximately 14.

**Claim 27 (previously presented):** The method of Claim 2 wherein the at least one pH adjuster adjusts the chemical solution to a pH in a range of approximately 10 to approximately 12.

**Claim 28 (previously presented):** The method of Claim 2 wherein the at least one

copper (Cu) ion source comprises copper(II) sulfate ( $\text{CuSO}_4$ ).

**Claim 29 (previously presented):** The method of Claim 2 wherein the at least one zinc (Zn) ion source comprises zinc dichloride ( $\text{ZnCl}_2$ ).

**Claim 30 (previously presented):** The method of Claim 2 the at least one complexing agent comprises ethylene diamine "EDA" ( $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$ ).